

IS : 851 - 1978
(Reaffirmed 1996)
Edition 2.1
(1987-12)

Indian Standard

**SPECIFICATION FOR SYNTHETIC
RESIN ADHESIVES FOR CONSTRUCTION
WORK (NON-STRUCTURAL) IN WOOD**

(First Revision)

(Incorporating Amendment No. 1)

UDC 668.395 : 674.21 : 694.6

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

Price Group 6

Indian Standard

SPECIFICATION FOR SYNTHETIC RESIN ADHESIVES FOR CONSTRUCTION WORK (NON-STRUCTURAL) IN WOOD

(First Revision)

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Indian Standard

SPECIFICATION FOR SYNTHETIC RESIN ADHESIVES FOR CONSTRUCTION WORK (NON-STRUCTURAL) IN WOOD (*First Revision*)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 20 February 1978, after the draft finalized by the Wood Products Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 Adhesives form one of the most important raw materials used in the plywood industry and wood work and joinery industry. The selection of the adhesive and its correct use are important factors controlling the quality of the plywood or the joinery work produced. In the context of this background of the industry, it has been found necessary to lay down standards governing the quality of the raw materials and the performance expected from the prepared glues.

0.3 The preparation of the adhesive and its correct use are other important aspects. Therefore, for the information of the users, the manufacturers shall furnish all the relevant information for the use of these adhesives in the manner indicated in Appendix A.

0.4 This standard covers both phenolic as well as aminoplastic synthetic resin adhesives. The phenolic resin adhesives are normally classified as BWP and BWR grade. The joints made with this type of adhesives are highly resistant to weather, micro-organisms, cold and boiling water, steam or dry heat. The aminoplastic resin adhesives generally classified as WWR or CWR grade adhesives of urea formaldehyde base, deteriorate rapidly on full exposure to weathering. These are, therefore, not recommended where high level of moisture is experienced. However, UF resins fortified either with melamine, phenol or resorcinol and urea formaldehyde melamine formaldehyde mixes show much improved performance over UF resins.

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0.5 This standard was first published in 1957. In this first revision, three types of adhesives covered in the earlier version have been re-designated and an additional type (BWR) has been included. The definition requirements and methods of tests as applicable to these types have been modified in light of experience.

0.6 This standard contains clauses **5.3.1** and **5.3.2** which permit the user to use his option for selection to suit his requirements at the time of placing orders.

0.7 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.8 This edition 2.1 incorporates Amendment No. 1 (December 1987). Side bar indicates modification of the text as the result of incorporation of the amendment.

0.9 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard prescribes the requirements for synthetic resin adhesives suitable for wood work (non-structural) and joinery.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 707-1976† and the following shall apply.

2.1.1 Assembly Time

2.1.1.1 Open assembly time— The time elapsing between the application of the adhesive and assembly of joint components.

2.1.1.2 Closed assembly time— The time elapsing between assembly of the joint components and the application of pressure.

2.1.2 Adhesive

2.1.2.1 Closed contact adhesive— A non-gap-filling adhesive suitable for use only in those joints where the surfaces to be joined may be brought into close contact by means of adequate pressure, and where glue line exceeding 0.12 mm may be avoided with certainty.

*Rules for rounding off numerical values (revised).

†Glossary of terms applicable to timber technology and utilization (second revision).

2.1.2.2 Gap filling adhesive — An adhesive suitable for use in those joints where the surfaces to be joined may or may not be in close or continuous contact owing either to impossibility of applying adequate pressure or to slight inaccuracies in machining.

2.1.3 Extender — A substance added to the adhesive either to reduce the cost of gluing or to reduce penetration through the veneers or both.

2.1.4 Filler — An inert substance, such as wood flour, added to alter the characteristics, for example, to reduce brittleness of a synthetic resin sometimes loosely and incorrectly used as interchangeable with 'extender'.

2.1.5 Fortifier — A substance used primarily to increase the boil resistance and durability of hot setting urea resins.

2.1.6 Hardener — A material used to promote the setting of the resin. It may be either in liquid or powder form. It is an essential part of the adhesive, the properties of which depend upon using the resin and hardener as directed.

2.1.7 Pot Life — The time between the mixing of the constituent parts of an adhesive and its reaching the age when it is no longer usable.

2.1.8 Shelf Life — The period for which the adhesive or adhesive components may be stored without affecting their suitability for use in accordance with the standard.

2.1.9 Spread of Adhesive — The area of surface covered by 1 kg of adhesive mix prepared in accordance with the manufacturer's instructions.

2.1.10 Synthetic Resin — Amorphous organic materials produced by the polymerization or condensation of one, two or, less frequently, three relatively simple compounds. The term is also applied to chemically modified natural resins. The properties of synthetic resins can vary widely depending upon their basic raw materials, proportions, and conditions of manufacture. All synthetic resins are classified broadly as thermosetting or thermoplastic.

2.1.10.1 Phenolic synthetic resin — A phenolic synthetic resin is derived from the reaction of phenol with an aldehyde.

2.1.10.2 Aminoplastic synthetic resin — An aminoplastic synthetic resin is derived from the reaction of urea, thio-urea, melamine, or allied compounds, or mixtures of these compounds with formaldehyde.

2.1.11 Synthetic Resin Adhesive — A composition, substantially consisting a synthetic resin of either the phenolic or aminoplastic type but including any hardening agent, fortifier, filler or extender, which may be required to be added before use according to the manufacturer's instructions.

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3. TYPES

3.1 Depending upon their degree of resistance to water and micro-organisms, synthetic resin adhesives for wood shall be of the following four types:

Boiling Water Proof	BWP
Boiling Water Resistance	BWR
Warm Water Resistance	WWR
Cold Water Resistance	CWR

3.1.1 Gap-filling and close contact adhesives of the four types shall be distinguished by the following symbols:

<i>Type</i>	<i>Symbol</i>	
	Gap-Filling Adhesive	Close Contact Adhesive
Boiling Water Proof	BWP/GF	BWP/CC
Boiling Water Resistance	BWR/GF	BWR/CC
Warm Water Resistance	WWR/GF	WWR/CC
Cold Water Resistance	CWR/GF	CWR/CC

4. KEEPING QUALITIES

4.1 The adhesives shall comply with the requirements specified under **5** after the resin and hardener have been stored in the original closed containers according to the manufacturer's instructions and up to the date recommended by the manufacturer.

5. TESTS

5.1 Sampling — A representative sample shall be drawn from each batch of adhesives. Such samples shall, in each case, be tested separately, and not be bulked with other samples or otherwise averaged.

5.2 Veneers for Test Pieces — Veneers used in the preparation of test pieces shall comply with the requirements specified in Appendix B.

5.3 Test Requirements — The test requirements for each type of adhesive shall be as given in Table 1. The gap-filling group shall be tested with both gap joints and close-contact joints, but the close-contact group shall be tested with close-contact joints only.

5.3.1 Routine test for each type of adhesive shall be the dry test(s) and the wet test(s) at the temperature appropriate to its type. However, if so required by the purchaser, the adhesives of the BWP, BWR and WWR types shall also be required to satisfy the requirements of the cold water test.

TABLE 1 TEST REQUIREMENTS FOR SYNTHETIC RESIN ADHESIVES AND THE CLAUSES CONCERNED

(Clause 5.3)

TEST REQUIREMENTS	DRY TEST		RESISTANCE TO WATER						*RESISTANCE TO MICRO-ORGANISM (MYCOLOGICAL TEST)	
	Gap Joint	Close Contact Joint	Boiling Water Test		Hot Water Test		Cold Water Test		Gap Joint	Close Contact Joint
			Gap joint	Close contact joint	Gap joint	Close contact joint	Gap joint	Close contact joint		
Mean Failing Load, kg, <i>Min</i>	205	275	100 for BWP 90 for BWR	150 for BWP 115 for BWR	100	150	180	200	180	200
7 TYPE DESIGNATION	CLAUSE REFERENCE									
BWP/GF	5.4.1	5.4.2	5.5.1	5.5.2	—	—	*5.5.1	*5.5.2	5.6.1	5.6.2
BWR/GF	5.4.1	5.4.2	5.5.1	5.5.2	—	—	*5.5.1	*5.5.2	5.6.1	5.6.2
WWR/GF	5.4.1	5.4.2	—	—	5.5.1	5.5.2	*5.5.1	*5.5.2	5.6.1	5.6.2
CWR/GF	5.4.1	5.4.2	—	—	—	—	5.5.1	5.5.2	—	—
BWP/CC	—	5.4.2	—	5.5.2	—	—	—	*5.5.2	—	5.6.2
BWR/CC	—	5.4.2	—	5.5.2	—	—	—	*5.5.2	—	5.6.2
WWR/CC	—	5.4.2	—	—	—	5.5.2	—	*5.5.2	—	5.6.2
CWR/CC	—	5.4.2	—	—	—	—	—	5.5.2	—	—

*Tests shall only be carried out when specifically required by the purchaser.

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5.3.2 When specifically required by the purchaser, adhesives of the BWP, BWR and WWR types shall satisfy the requirements of the mycological test as given under **5.6**.

5.4 Dry Strength

5.4.1 Gap Joints — The average failing load of a set of six test pieces prepared by the method specified in Appendix C conditioned appropriately as specified in Appendix D, and when pulled by the method described in Appendix E shall be not less than 205 kg for all types.

5.4.2 Close Contact Joints — The average failing load of a set of six test pieces prepared by the method described in Appendix F, conditioned appropriately as specified under Appendix D and when pulled in accordance with Appendix E shall be not less than 275 kg for all types.

5.5 Resistance to Water

5.5.1 Gap Joints — The average failing load for a set of six test pieces prepared by the method specified in Appendix C, conditioned appropriately as specified in Appendix D and when pulled in accordance with Appendix E after treatment in the manner specified in Appendix G for the time and temperature given in Table 2 shall be not less than the corresponding value indicated therein.

TABLE 2 RESISTANCE TO WATER (GAP JOINTS)

(Clauses 5.5.1 and G-1.1)

TYPE	TEMPERATURE OF WATER IN WHICH TEST PIECES SHALL BE IMMERSSED	TIME OF IMMERSION	MEAN FAILING LOAD
(1)	(2)	(3)	(4)
	0°C	h	kg
BWP	100 (or at the boiling point of water)	6	100
BWR	do	3	90
WWR	70 ± 2	3	100
CWR	27 ± 2	16 to 24	180

5.5.2 Close-Contact Joints — The average failing load for a set of six test pieces prepared by the method specified in Appendix F, conditioned appropriately as specified in Appendix D, and when pulled by the method described in Appendix E, after treatment in accordance with Appendix G for the time and temperature given in Table 3 shall be not less than the corresponding values indicated therein.

TABLE 3 RESISTANCE TO WATER (CLOSE-CONTACT JOINTS)

(Clauses 5.5.2 and G-1.1)

TYPE	TEMPERATURE OF WATER IN WHICH TEST PIECES SHALL BE IMMERSED	TIME OF IMMERSION	MEAN FAILING LOAD
(1)	(2)	(3)	(4)
	0°C	h	kg
BWP	100 (or at the boiling point of water)	6	150
BWR	100 (or at the boiling point of water)	3	115
WWR	70 ± 2	3	150
CWR	27 ± 2	16 to 24	200

5.6 Resistance to Micro-Organisms (Mycological Test)

5.6.1 Gap Joints — The average failing load for a set of six test pieces prepared by the method specified in Appendix C. Conditioned appropriately as specified in Appendix D, and when pulled by the method described in Appendix E, after the treatment in accordance with 4 of IS : 1734 (Part 7)-1983* shall be not less than 180 kg for all types.

5.6.2 Close-Contact Joints — The average failing load for a set of six test pieces prepared by the method specified in Appendix F, conditioned appropriately as specified in Appendix D, and when pulled by the method described in Appendix E, after the treatment in accordance with 4 of IS : 1734 (Part 7)-1983* shall be not less than 200 kg for all types.

5.7 Re-Test — In the event of failure to comply with the requirements of any test(s), the batch of material concerned shall be re-tested in respect of such requirement(s). In the event of failure of re-test, the batch shall be rejected.

6. MARKING

6.1 Each container shall be legibly and indelibly marked with the following:

- a) Manufacturer's name or distinguishing mark,
- b) Description of material (see 3),
- c) Manufacturer's reference number,
- d) Batch number,

*Methods of test for plywood (second revision).

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- e) Date of manufacture,
- f) The date beyond which the adhesive or adhesive components shall not be used when stored under conditions recommended by the manufacturer,
- g) Reference to the manufacturer's instructions for use, and
- h) The words 'to be stored in a cool dry place'.

6.1.1 The product may also be marked with Standard Mark.

6.2 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

A P P E N D I X A

(Clause 0.3)

INFORMATION TO BE FURNISHED BY THE MANUFACTURER REGARDING THE USE OF ADHESIVES

A-1. GUIDANCE REGARDING USE

A-1.1 The manufacturer shall furnish written instructions detailing the manner in which each resin or recommended combination of resin(s), hardner(s), filler fortifiers and extenders shall be used. The instructions shall give information in the manner indicated under **A-1.2** to **A-1.6**, where applicable.

A-1.2 Storage Life of Adhesive or Adhesive Components — The manufacturer shall specify the storage life of the adhesive components.

A-1.3 Preparation for Use — The preparation of resin, hardener, fortifier, filler and extender, method of mixing, recommended types of mixing, apparatus, and necessary precautions of any kind shall be stated.

A-1.4 Usable Life of Mixed Adhesive or Pot Life — The maximum time shall be stated during which the adhesive maintained at temperatures of 15, 20, 25, 30, 40 and 45°C would remain fit for use so as to comply with the requirements of the specification.

A-1.5 Methods of Use — Guidance on the following points shall be given:

- a) Range of moisture content of wood;
- b) Preparation of wood surfaces;
- c) Methods of application, such as single or double spread;
- d) Normal amounts of spread for single glue line;
- e) Maximum and minimum open and closed assembly times;
- f) Recommended range of pressures in N/m^2 (kg/cm^2);
- g) Post-treatment of finished product; and
- h) Cleaning of containers and test.

A-1.6 Setting Times and Conditions — The recommended range of temperature to which the adhesive in any glue line may be subjected and also the minimum and maximum times for which pressure shall be maintained on unstressed joints at temperatures within the range shall be stated.

A P P E N D I X B

(Clauses 5.2 and F-1.1)

VENEERS FOR TEST PIECES

B-1. REQUIREMENTS

B-1.1 The Veneers shall be rotary-cut *canarium* spp. Vallapine or Makai 3.00 ± 0.15 mm thick with the growth rings approximately parallel to the face.

B-1.2 Veneers shall be smooth-cut on both faces, straight grained and free from all defects, at least over the area that will form the middle 50 mm length of the test pieces, and may be slightly sanded. Elsewhere, the occurrence of slight defects, such as small uplifts, small live knots and short grain, may be disregarded. The moisture content of the veneers shall be 12.0 ± 2.5 percent for liquid adhesive and 12.0 ± 2.0 percent for film adhesive, as may be recommended by the manufacturer.

A P P E N D I X C

(*Clauses 5.4.1, 5.5.1 and 5.6.1*)

PREPARATION OF TEST PIECES FOR DETERMINATION OF FAILING LOAD (GAP JOINTS)

C-1. TEST SLIPS

C-1.1 Each test piece shall be made from two slips of *canarium* spp. Vallapine or Makai veneer complying with the requirements of Appendix B, 150 mm long, 25.0 ± 0.3 mm wide and 3.00 ± 0.15 mm thick, joined together with the adhesive under test and assembled as described in **C-3**.

C-2. PREPARATION OF ADHESIVE

C-2.1 The adhesive shall be prepared and used in accordance with the instructions supplied by the manufacturer. Where the manufacturer's instructions permit separate application of the resin and hardener in joints, 1.0 mm thick, the test pieces shall be prepared by the separate application method.

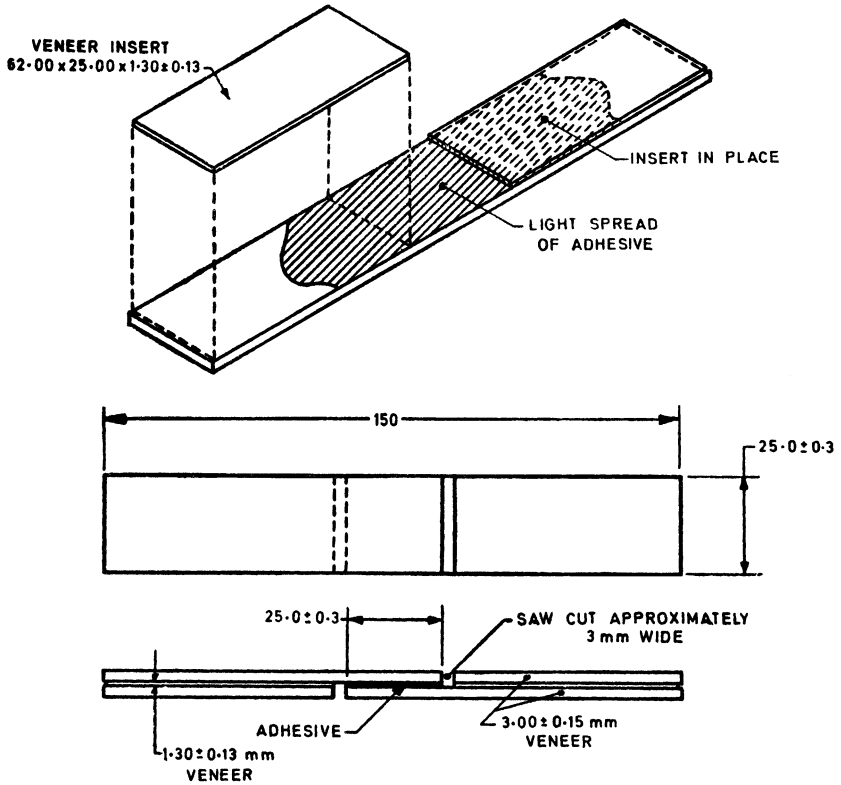
C-3. PREPARATION OF TEST PIECES

C-3.1 The test pieces shall be prepared under ordinary room conditions, except where otherwise directed by the manufacturer. One of the 150 mm slips forming a joint shall be coated with adhesive over the middle third of its length (*see* Fig. 1) and have inserts of $62.0 \times 25.0 \times 1.30 \pm 0.13$ mm thick, fitted as shown in Fig. 1. The resultant gap shall be filled with an excess of the adhesive. The second slip to make the complete joint shall be coated with adhesive over the middle third of its length and placed in position; excess of adhesive shall be squeezed out when the clamp is tightened.

C-3.1.1 Where separate application of resin and hardener is permitted by the manufacturer, the lower face of the top slip, and, if required, the lower face of the inserts, shall be coated with hardener, the resin being applied to the upper surfaces of the bottom slip and inserts, and to fill the gap.

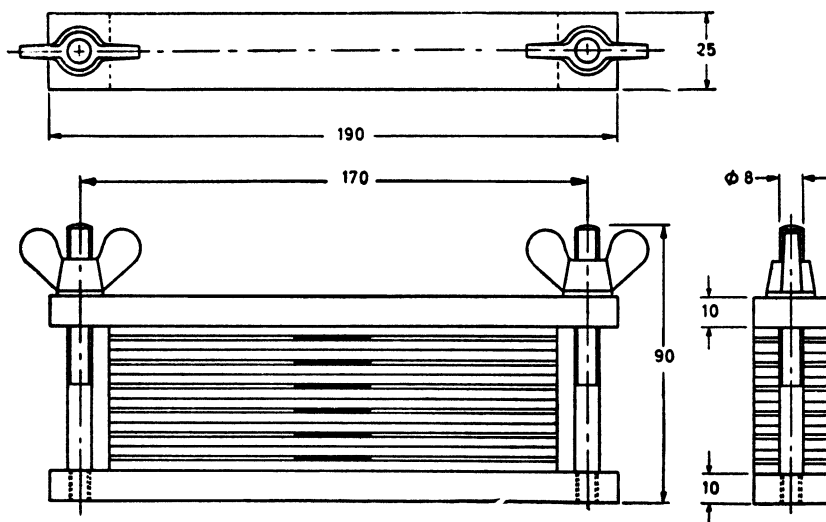
C-3.1.2 After assembly of the test pieces, they shall be placed immediately in a suitable clamp, a convenient form of which is shown in Fig. 2. The clamp shall be screwed down until 'finger tight'.

NOTE — The saw cuts shown in Fig. 1 shall be made after the test pieces have been conditioned (*see* Appendix D).



All dimensions in millimetres.

FIG. 1 GAP TEST PIECE SHOWING METHOD OF FITTING INSERTS



All dimensions in millimetres.

FIG. 2 CLAMPING DEVICE FOR SIX GAP TEST PIECES

APPENDIX D

(Clauses 5.4.1, 5.4.2, 5.5.1, 5.5.2, 5.6.1 and 5.6.2)

CONDITIONING OF TEST PIECES

D-1. COLD SETTING GLUES

D-1.1 As soon as possible after assembling the test pieces, while still in the clamps, shall be placed in an oven at the room temperature ($27 \pm 2^\circ\text{C}$) and shall remain there in the clamp for 16 to 24 hours. After release from the clamps, the test pieces shall be freely exposed to the air in the oven for a further period of 5 to 8 days or for such other period as specified by the manufacturer.

D-2. WARM SETTING GLUES

D-2.1 As soon as possible after assembling the test pieces, while still in the clamps, shall be placed in a container (see Note) which shall then be put into an oven running with $\pm 2^\circ\text{C}$ of a specified temperature where it shall remain for a stipulated period, the precise temperature

and time being in accordance with the instructions of the manufacturer. After treatment in the oven, and as soon as the container and the contents have cooled so that they can be handled conveniently, the test pieces shall be removed from the clamps and stored at room temperature ($27 \pm 2^\circ\text{C}$) for 16 to 26 hours prior to pulling.

NOTE — The purpose of the container is to prevent excessive loss of moisture from the test pieces during the treatment at high temperatures. It shall, therefore, be made of a reasonably impervious material and have a close-fitting lid. A small hole shall be provided for the changes in volume of the air during the heating and cooling.

D-2.2 The manufacturer may prescribe and use any other method of heating and conditioning the test piece, provided details of the process are made available to the user.

A P P E N D I X E

(*Clauses 5.4.1, 5.4.2, 5.5.1, 5.5.2, 5.6.1 and 5.6.2*)

PULLING TEST PIECES AND COMPUTING THE RESULTS

E-0. GENERAL

E-0.1 Due to the non-axial transmission of load through the prescribed test pieces and the consequent tendency to bend during pulling, the strength which the joints develop on test is influenced by the extent to which the bending is restrained. Testing machines vary widely in this respect, one extreme being represented by the shot loading type of machine, in which the upper grips are suspended through two articulated joints from a lever free to move longitudinally, while the other extreme is typified by the standard high-capacity testing machine with substantial wedge grips in a massive head in which the ends of the test pieces are maintained rigidly in line throughout the test.

E-0.2 At present there is insufficient knowledge about the influence of the various factors involved to enable them to be taken into account for purposes of specifications; nor can any of the existing testing machines be regarded as sufficiently near the ideal to serve as a standard. Pending the development of a standard method of test, control is limited to the rate at which the load is applied to the test piece, to the distance between the grips, and to the accuracy with which the load is measured. The rate of loading mentioned in Method 2 under **E-2.2** is designed to take into account the slip experienced with wedge grips, particularly when testing joints after soaking.

E-1. ACCURACY OF TESTING MACHINE

E-1.1 The test pieces shall be pulled in a testing machine capable of measuring the breaking load with an accuracy of ± 1 percent.

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E-2. RATE OF LOADING

E-2.1 In testing machine provided with a means of controlling the rate of increase of load, the rate of increase of load shall be between 135 kg and 270 kg/min.

E-2.2 In testing machines, provided with a means of controlling the rate of separation of the straining heads, one of the following two methods shall be applicable:

Method 1

A device shall be provided, incorporating a pointer moving at constant speed over a scale graduated so as to indicate a rate of increase of load within the limits of **E-2.1**, with which the load indicator of the testing machine shall be caused to move in unison by appropriate manipulation of the rate of strain control. A scale having 45 divisions to the full circle (corresponding to the mean rate of loading of 202.5 kg/min) placed behind the second hand of a clock, would be a suitable device. The necessary limits of accuracy would be maintained by keeping the pointers in agreement within ± 33 percent.

Method 2

The straining rate shall be such that the time taken to pass from one quarter to the full specified minimum load shall be within the limits which would apply under **E-2.1** (for example, in the case of a specified minimum load of 90 kg, the time interval between 90/4 = 22.5 kg load and 90 kg load, that is in increasing the load by 67.5 kg should be between 67.5/135 and 67.5/270 minutes, which is between 0.5 and 0.25 minutes).

E-3. DISTANCE BETWEEN THE GRIPS

E-3.1 The distance between the grips of the testing machine shall be between 65.0 and 70.0 mm in the case of gap joints and between 115 and 120 mm in the case of close-contact joints.

E-4. COMPUTATION OF RESULTS

E-4.1 The average failing load for each test shall be computed from the corresponding group of six test pieces.

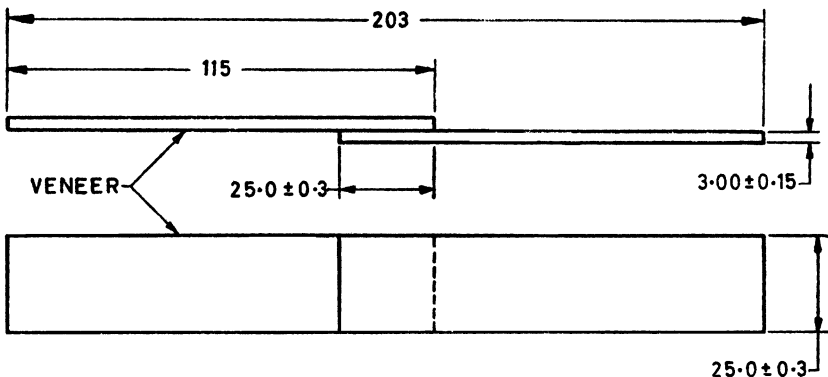
APPENDIX F

(Clauses 5.4.2, 5.5.2, 5.6.2 and B-1)

PREPARATION OF TEST PIECES FOR DETERMINATION OF FAILING LOAD (CLOSE-CONTACT JOINTS)

F-1. TEST SLIPS

F-1.1 Each test piece shall be made from two slips of *canarium* spp. Vallapine or Makai veneer complying with the requirements given under **B-1**. It shall be 115 mm long, 25.0 ± 0.3 mm wide and 3.15 ± 0.15 mm thick, joined together with the adhesive under test so as to produce a 25.0 ± 0.3 mm overlap joint (see Fig. 3).



All dimensions in millimetres.

FIG. 3 CLOSE-CONTACT TEST PIECE

F-2. PREPARATION OF ADHESIVE

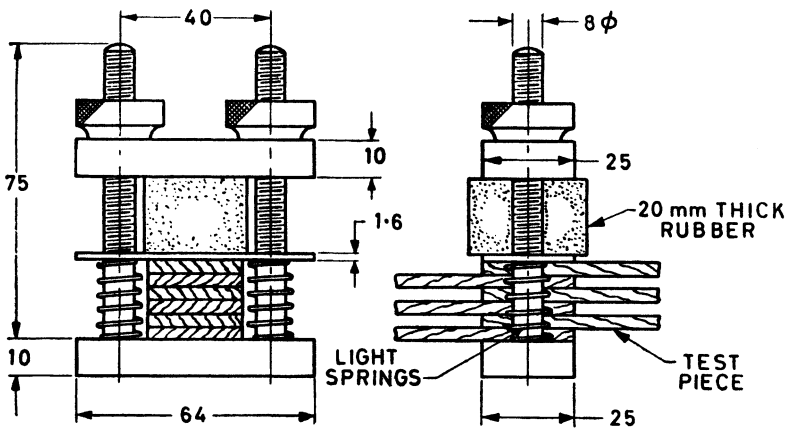
F-2.1 The adhesive shall be prepared and used in accordance with the instructions supplied by the manufacturer. Where these instructions permit both separate application of the resin and hardener and the use of mixed adhesive, the test pieces shall be prepared by the separate application method.

F-3. PREPARATION OF TEST PIECES

F-3.1 Test pieces shall be prepared under ordinary room conditions, except where otherwise directed by the manufacturer.

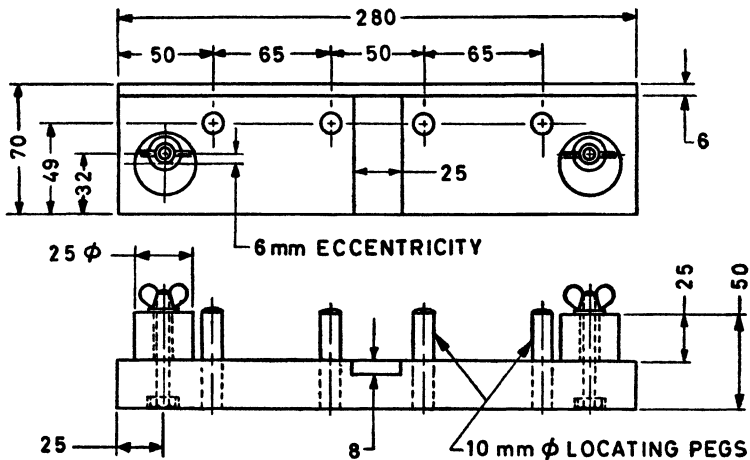
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F-3.2 The adhesive shall be applied uniformly to one of the two faces forming a joint or as prescribed by the manufacturer. The joints shall be made between the smooth faces of the veneers. The slips forming a joint shall be placed in contact without rubbing, immediately the adhesive is applied, or after such period as may be prescribed by the manufacturer. When the test pieces have been prepared, they shall be placed immediately in a suitable clamp, a convenient form of which is shown in Fig. 4. Sufficient pressure shall be applied to ensure good contact and generally about 50 kg is adequate. With the form of clamp shown in Fig. 4, this pressure may be obtained by screwing down until 'finger tight'. A convenient jig for locating the clamp and its contents is shown in Fig. 5.



All dimensions in millimetres.

FIG. 4 CLAMPING DEVICE FOR HOLDING SIX TEST PIECES



All dimensions in millimetres.

FIG. 5 WOODEN JIG FOR LOCATING TEST PIECES IN CLAMP

APPENDIX G

(Clauses 5.5.1 and 5.5.2)

WATER RESISTANCE TEST

G-1. TEST SAMPLES

G-1.1 The test pieces shall be completely immersed in water in accordance with the conditions of Tables 2 and 3, as may be required.

G-2. PROCEDURE

G-2.1 By the use of suitable racks to hold the test pieces, water shall have free access to all surfaces, and shall be at the temperature stipulated when the test pieces are initially immersed. After treatment at the higher temperatures; the test pieces shall be cooled immediately to approximately room temperature by immersing in cold water, in which they shall remain until mechanically tested, and the test shall be carried out within 24 hours of the initial cooling. Test pieces undergoing the cold water test shall be pulled immediately after removal from the water.

Appendix H Deleted

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(*Continued from page 2*)

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